NTU scientists develop handheld, high-resolution medical imaging device

Scientists at Nanyang Technological University, Singapore (NTU Singapore) have developed the prototype of a handheld medical imaging device that can produce images down to resolutions of 1 to 2 micrometres.

This is detailed enough to spot the first signs of tumours in specific cells and is about 100 times higher resolution than what X-ray computed tomography (CT) and Magnetic Resonance Imaging (MRI) machines can achieve.

The technology behind the device is a result of six years of optical imaging research and was jointly developed by a team from NTU with researchers at the Harvard Medical School and the University of Alabama, USA.

Relaying on a new imaging technology known as 'optical coherence tomography' (OCT), the device emits a spectrum of light between 700 to 950 nanometres, known as near-infrared light. This harmlessly penetrates human tissue and organs, and the device then measures the delay time of the 'echo' from its light waves as it strikes different tissue structures. This information will then be used to construct cross-section images of what is being scanned.

The results are sent in real-time to a computer system running software developed at NTU, which assists in diagnosing by comparing the 2D cross-section images into a three-dimensional picture and presenting different parts in colour.

The NTU researchers say that their prototype was designed to be used by medical professionals who do not specialise in imaging or pathology, allowing them to scan patients using the new device in clinics or at the bedside. Patients would not face the inconvenience of waiting for MRI or CT scanner availability and requiring attendance at a specialised facility.

NTU Associate Professor Liu Junfeng, who led the research team, said, "Our device is a fraction of the size of existing machines and produces clear high-resolution images in real-time. It uses light to harmlessly penetrate the skin, and it does not involve specialised lead-shielded X-ray equipment or MRI scanners. It is small enough to be handheld, so images could be captured by the bedside."

The prototype device has undergone clinical trials at Wuhan University's Endocrine Centre, and has proven to be in detecting abnormal colon polyps to the same level of accuracy as trained pathologists.

During the preliminary trial at the Renmin Hospital of Wuhan University, endoscopists used the device on rectal tissue samples from patients known to have colon polyps - abnormal growths in the colon or rectum. The samples were imaged in real-time by the device, and its accuracy of whether they were malignant or benign was found to be 95 per cent accurate after comparison with an evaluation of the same samples, by senior pathologists. These findings were published in Clinical and Translational Gastroenterology in June 2019.

The device is now being commercialized by a Chinese medical technology firm, Suzhou Sai Liu Biomedical Imaging Technology Co. Ltd.

A key premise of the micro-OCT device's potential ability to spot the first signs of cancers, such as stomach and skin, which begin in the nuclei of epithelial cells measuring about 1 to 2 micrometres, epithelial cells are part of the barrier between the inside and outside of the body, i.e., living inside the throat, intestine, blood vessels, and organs and are almost impossible to image using current machines that cannot penetrate beyond half a millimetre. "It is our hope that in future, doctors might be able to use a device like ours to practically identify disease, as they develop, at the cellular level, in real-time, and in high-resolution," said Assoc Prof Liu. "Through earlier detection, we believe that patients will receive an earlier diagnosis and if necessary, get treatment faster."

Not involved in the study, Dr Li Zhang, a Consultant Haematologist at the National University Hospital in Singapore, said, "This is a groundbreaking technology that could have widespread clinical applications. These range from real-time imaging of tissues at a microscopic level to even detecting cancer cells in the blood. All this could lead to early and more accurate detection of cancer. An additional advantage is that being a portable device, it could be used at the bedside, doctors and even in patient's homes which would extend the accessibility of this technology and cut down on waiting time."

Prof Liu and his team are conducting more in-depth research into OCT technologies, to further improve the device and extend industry collaboration with other healthcare companies.